PACIFIC COOPERATIVE STUDIES UNIT
UNIVERSITY OF HAWAI`I AT MĀNOA
Dr. David C. Duffy, Unit Leader
Department of Botany
3190 Maile Way, St. John #408
Honolulu, Hawai'i 96822

Technical Report 141

Herpetological inventory in West Hawai`i national parks: Pu`uhonua o Hōnaunau National Historical Park Kaloko-Honokōhau National Historical Park Pu`ukoholā Heiau National Historic Site

April 2007

Jason Bazzano[1]

1. Pacific Cooperative Studies Unit (University of Hawai`i at Mānoa), NPS Inventory and Monitoring Program, Pacific Island Network, PO Box 52, Hawai`i National Park, HI 96718

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ABSTRACT

The National Park Service Pacific Island Network initiated an inventory of the species of amphibians and reptiles within the national parks of Hawai`i with the goal of documenting 90% or greater of the species present. This report addresses inventories of herpetofauna at the three coastal national parks in West Hawai`i: Pu`uhonua o Hōnaunau National Historical Park (PUHO), Kaloko-Honokōhau National Historical Park (KAHO), and Pu`ukoholā Heiau National Historic Site (PUHE). Work was conducted between 19 July 2004 and 15 September 2004, surveying for all reptile and amphibian species that had established populations on park properties. Throughout this project, special emphasis was placed upon the following three species of herpetofauna: coqui frog (*Eleutherodactylus coqui*), Jackson's chameleon (*Chamaeleo jacksonii xantholophus*), and brown anole (*Anolis sagrei*); these species were identified as "aliens of concern," or species that pose the greatest risk to native Hawaiian species or ecosystems. We found nine species of herpetofauna that did not fall into the high-risk category at PUHO, seven species at KAHO, and three species at PUHE. At this time, we suspect that none of the alien species of concern have established breeding populations in any of the three parks investigated. However, there are reports of several populations of some of these species of concern located on adjacent properties that may establish residence within the parks in the immediate future. We recommend close monitoring on behalf of the parks in identifying outbreaks, and initiating containment measures outside the national parks while control remains a viable option.

INTRODUCTION

This study was conducted as part of the NPS Inventory and Monitoring program's effort to document vertebrate and vascular plant organisms in national park system units. Results for herpetofauna surveys in Kalaupapa (Molokai), Haleakalā (Maui), and Hawai`i Volcanoes (Hawai`i Island) national parks were reported by Kraus (2005). This report presents results for the three national park system units on the west side of Hawai`i Island.

The nativity of terrestrial Hawaiian herpetofauna is notable in that every species has been introduced by humans, whether intentionally or otherwise (McKeown 1996). Many species have established successful populations throughout the Hawaiian archipelago, and amphibians and reptiles are now frequently encountered in a wide range of habitats. However, very little is known about the distribution of these species and thus their potential impact upon native Hawaiian ecosystems.

The primary goal of this inventory was to document 90% or greater of the species of amphibians and reptiles within park boundaries. In addition, this project addressed species that pose a considerable risk to native Hawaiian species or ecosystems, referred to in this report as "aliens of concern." For the purpose of this project, E.W. Campbell[1] has identified three species that have been introduced to Hawai`i that fit the above criteria defining an alien of concern: coqui frog (*Eleutherodactylus coqui*), Jackson's chameleon (*Chamaeleo jacksonii xantholophus*), and brown anole (*Anolis sagrei*). The second goal for this inventory was to determine if species of concern are present in the parks and if so, to investigate their distribution and abundance. Estimates of species distribution and abundance in the parks are crucial when making informed decision regarding the initiation of control mechanisms. These estimates additionally create a foundation of baseline data with which long-term monitoring programs might be developed.

This paper discusses which herpetofauna were encountered in the parks, their relative abundance, their association with particular vegetation types (if any), and potential herpetofauna-related threats towards the parks' native ecosystems.

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[1] US Fish and Wildlife Service, Pacific Islands Fish and Wildlife Office, 300 Ala Moana Blvd, Honolulu, HI 96850

METHODS

This study was conducted at Pu`uhonua o Hōnaunau National Historical Park (PUHO), Kaloko-Honokōhau National Historical Park (KAHO), and Pu`ukoholā Heiau National Historic Site (PUHE) between 19 July 2004 and 15 September 2004.

PUHO is the southernmost of the three parks investigated and has some of the most varied habitat. The total area of this park is 74 ha and while the majority of this is dry coastal scrub with vegetation largely characterized by non-native introductions, an unconnected upslope segment of the park provides an entirely different habitat. This area has been cultivated into a botanical garden containing an assortment of native plant species as well as Polynesian introductions. Although small in size (only about 1.2 ha), this plot greatly enriches the habitat diversity of the park. A newly purchased plot of land immediately south of the coastal segment of the park is scheduled to join the park in the near future; this area was not investigated during this study. PUHO receives the most rainfall of any of the three parks investigated, at a median annual precipitation rate of 1,000-1,500 mm (State of Hawai`i DLNR, 1970). PUHO also experiences the highest number of visitors among the three parks surveyed in this study, with approximately 840,000 visitors in 2004.

KAHO is the largest park of the three, with its entire area of 469 ha (including 241 ha of marine area), situated along the coast. The variable habitat is dominated by lava flows largely devoid of vegetation, savannah, grassland, inland scrub, and inland and coastal forest. KAHO also has two large fishponds (human-made enclosures bordering, but separate from, the ocean and of variable salinity due to freshwater springs) and numerous anchialine pools scattered throughout the park. The median annual precipitation at KAHO is 500-750 mm (State of Hawai`i DLNR, 1970). KAHO received approximately 90,000 visitors in 2004.

At 35 ha, PUHE is the smallest of the three parks. Habitat diversity is low, with kiawe thickets and open grassland being the two dominant habitat types. PUHE is also the driest of the three parks with a median annual precipitation of less than 250 mm (State of Hawai`i DLNR, 1970).

All surveys were visual encounter surveys. In order to maximize the number of species encountered, as many different habitats as possible within each park were examined, both during the day and at night. A GPS tracklog monitored the path of the surveys, which were irregular in length and direction; preexisting trails were used for some of the surveys, though off-trail surveys were performed when vegetation permitted. The track logs were later superimposed over vegetation maps provided by the USGS Gap Analysis Program to look for trends associated with the general habitat types that were surveyed. These maps are available through I&M, but vegetation types were too coarse in resolution to allow for an analysis of herpetofauna-vegetation habitat associations. Instead, we performed this analysis based on detailed habitat descriptions from the field notes. A GPS waypoint was taken for every reptile and amphibian encountered. Digital photographs were taken of individuals as a supplementary mode of documentation (in addition to preserved vouchers), and habitat photographs were taken periodically to be used as a visual record of the habitat types surveyed. Temperature and humidity readings were recorded at the beginning and the end of each survey, as were wind intensity and sky conditions. When individual herpetofauna were encountered, a basic microhabitat description (substrate plus immediate vicinity) was recorded; this information was used to determine trends in species-

specific habitat preference. Times that specimens were found and number of individuals present were also recorded. Identifications were made using McKeown's (1996) book, *A Field Guide to Reptiles and Amphibians in the Hawaiian Islands.*

Efforts were made to collect two sets of male and female voucher specimens of each species from each park. One set will be stored at Bishop Museum[2], and one set will be stored at Hawai`i Volcanoes National Park[3]. Vouchers were collected using a lizard noose, a small net, by hand, or with a pole with duct tape affixed to the end, sticky side out depending upon the species and circumstance. Vouchers were euthanized in a chloretone solution, fixed in 10% formalin, and preserved in 70% ethanol. Snout-vent length, total length, and sex were recorded (post-preservation) for the vouchers.

[2] 1525 Bernice Street, Honolulu, HI 96817
[3] 1 Crater Rim Drive, Hawai`i National Park, HI 96718

RESULTS

No alien species of concern were encountered during our surveys at PUHO, though there have been two reliable reports of Jackson's chameleons by staff within the park. Both of the sightings were immediately adjacent to the parking areas. At KAHO we did not encounter any alien species of concern, nor were there any reported sightings of aliens of concern within the park boundaries. However, there have been reports by park staff of both Jackson's chameleons and coquis from nearby areas. There were no alien species of concern found at PUHE, nor were any reports of these species in the nearby area brought to our attention. Brown anoles have not been reported from areas within or near any of the parks surveyed.

Although identifying populations of alien species of concern was the main urgent focus of this project, all the other species of herpetofauna in the parks were censused as well. Results are summarized in Table 1, which lists species and their status within each park.

Table 1. *Established and inchoate herpetofaunal populations in the three West Hawai`i national parks; based on surveys in July – September 2004.*

			Presence in parks		
Family	**Scientific Name**	**Common name**	**PUHO**	**KAHO**	**PUHE**
Bufonidae	Bufo marinus	giant toad, cane toad, bufo toad, bufo	L**	L	-
Chamaeleonidae	Chamaeleo jacksonii xantholophus	Jackson's chameleon	N**	N	-
Cheloniidae	Chelonia mydas mydas	Pacific green sea turtle, green sea turtle, honu	E	E	-***
Gekkonidae	Gehyra mutilata	stump-toed gecko	E	E	-
Gekkonidae	Hemidactylus frenatus	house gecko	E	E	E
Gekkonidae	Hemiphyllodactylus typus	tree gecko	E	E	-
Gekkonidae	Lepidodactylus lugubris	mourning gecko	E	E	-
Gekkonidae	Phelsuma laticauda laticauda	gold dust day gecko	E	E	E
Iguanidae	Iguana iguana	green iguana, iguana	N	-	-
Leptodactylidae	Eleutherodactylus coqui	coqui treefrog, coqui	N	N	-
Leptodactylidae	Eleutherodactylus planirostris	greenhouse frog	-	-	-
Polychridae	Anolis carolinensis	green anole	E	-	-
Scincidae	Cryptoblepharus poecilopleurus	oceanic snake-eyed skink, snake-eyed skink	-	E	-
Scincidae	Lampropholis delicata	metallic skink	E	-	-
Typhlopidae	Ramphotyphlops braminus	brahminy blind snake, island blind snake, Hawaiian blind snake, blind snake	E	L**	E

E = encountered.
L = likely current inhabitants of the park, though not encountered during this project. Based on habitat types present and reports of target taxa by park staff.
N = not encountered, not yet established, though has established populations in the surrounding area.
- = not encountered, not yet established, no known established populations in the surrounding area.
** Reliable reports from within the park, though not encountered during this survey.
*** May be an incidental visitor.

At all parks surveys were conducted during both day and night time hours. Table 2 shows the length of time spent during the day and night per park and summarizes the number of individuals for each species observed during daytime versus night time hours. More detailed data listing survey times and number of individuals per species encountered are listed in Appendix C.

Table 2. *Inventory effort and results for day time versus night time at the three West Hawai`i national parks.*

	KAHO Day	KAHO Night	PUHE Day	PUHE Night	PUHO Day	PUHO Night
Total # of Days/Nights	3	5	8	3	17	5
Total Duration (hrs:min)	11:27	20:05	24:49	13:17	31:51	15:12
Anolis carolinensis					13	1
Chelonia mydas mydas	5	9			3	
Cryptoblepharus poecilopleurus	6					
Gehyra mutilata		10				27
Hemidactylus frenatus	3	85	98	219	16	61
Hemiphyllodactylus typus		1				1
Lampropholis delicata					14	
Lepidodactylus lugubris	1	56			11	67
Phelsuma laticauda laticauda	17	0	12		32	2
Ramphotyphlops braminus			1	6	1	
unidentified gecko			4		13	2
unidentified lizard	1				2	
unidentified skink					3	

Pu`uhonua o Hōnaunau National Historical Park

We encountered nine herpetofauna species representing five different families at PUHO. In addition to these confirmed species, reports from residents near PUHO indicate that two species of herpetofauna that were not found in the park, iguana (*Iguana iguana*) and the coqui frog, have likely established populations near the upslope botanical garden of the park which is 1.5 km away. However, it is unclear how long these species have been seen in this area. We know of no voucher specimens that been collected in this area for either iguanas or coqui frogs. The scope of the current inventory did not allow time for surveys in the surrounding area of this national park to verify the anecdotal evidence.

PUHO's non-contiguous upslope botanical garden, while small in size, harbored eight out of nine of the herpetofauna species encountered anywhere in the park. The only exception was the green sea turtle (*Chelonia mydas mydas*). Additionally, four of the nine species found at PUHO were only found at the botanical garden: the green anole (*Anolis carolinensis*), the tree gecko (*Hemiphyllodactylus typus*), the metallic skink (*Lampropholis delicata*), and the blind snake (*Ramphotyphlops braminus*). Figure 1 shows survey tracks and sites of herpetofauna encounters at PUHO.

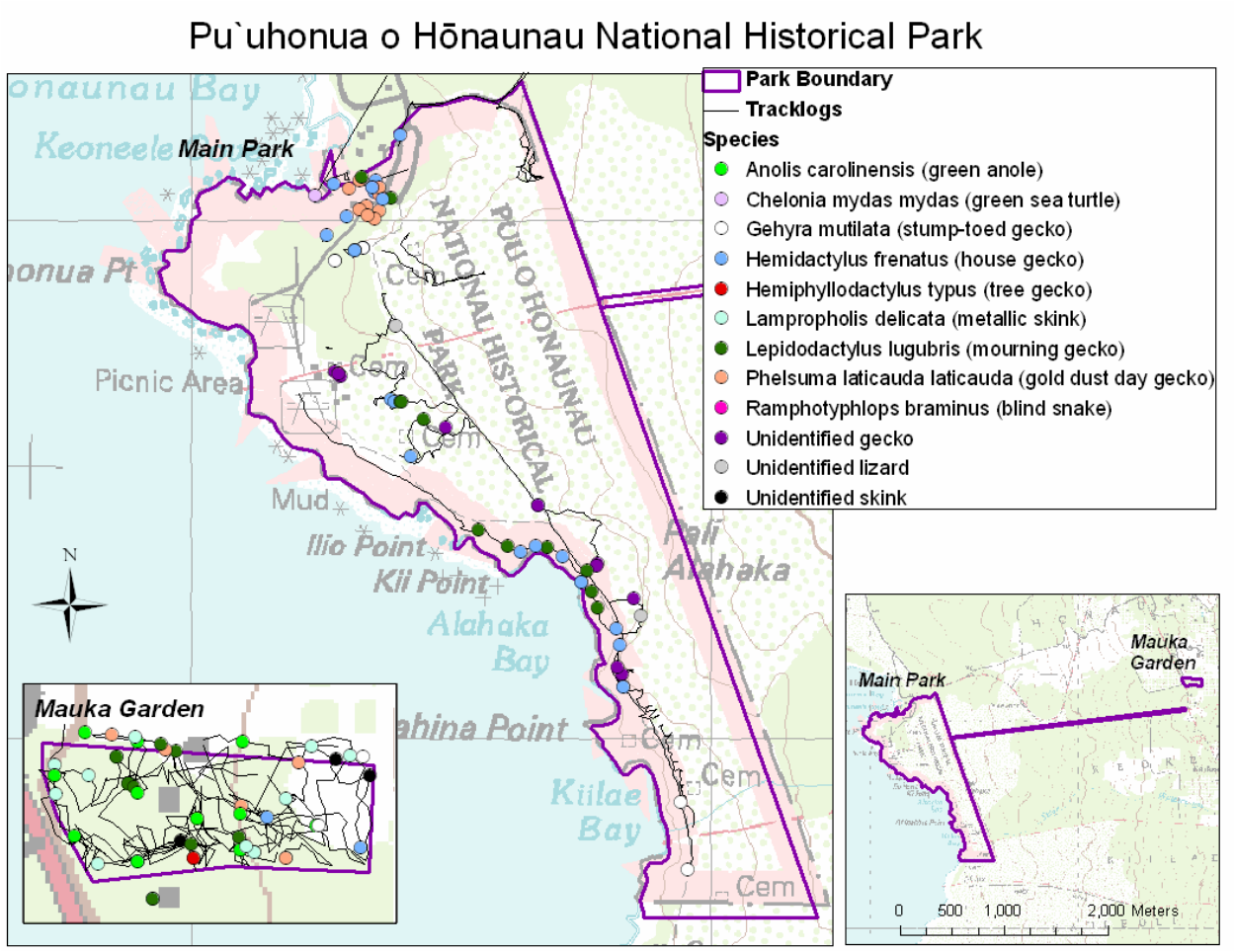

Figure 1. Map of survey tracks and herpetofauna encounters at Pu`uhonua o Hōnaunau National Historical Park, 2004

Kaloko-Honokōhau National Historical Park

KAHO was found to have seven species of herpetofauna from three different families (Table 1). Like PUHO, each family was represented by one species, with the exception of Gekkonidae, which had five representative species. Also like PUHO, Jackson's chameleons and coqui frogs have been reported from nearby areas, but it is uncertain when they were first observed. Again, we know of no voucher specimens that been collected in this area for either iguanas or coqui frogs. Due to the limited scope of the current inventory we were unable to conduct surveys in surrounding lands.
Figure 2 shows survey tracks and sites of herpetofauna encounters in this park.

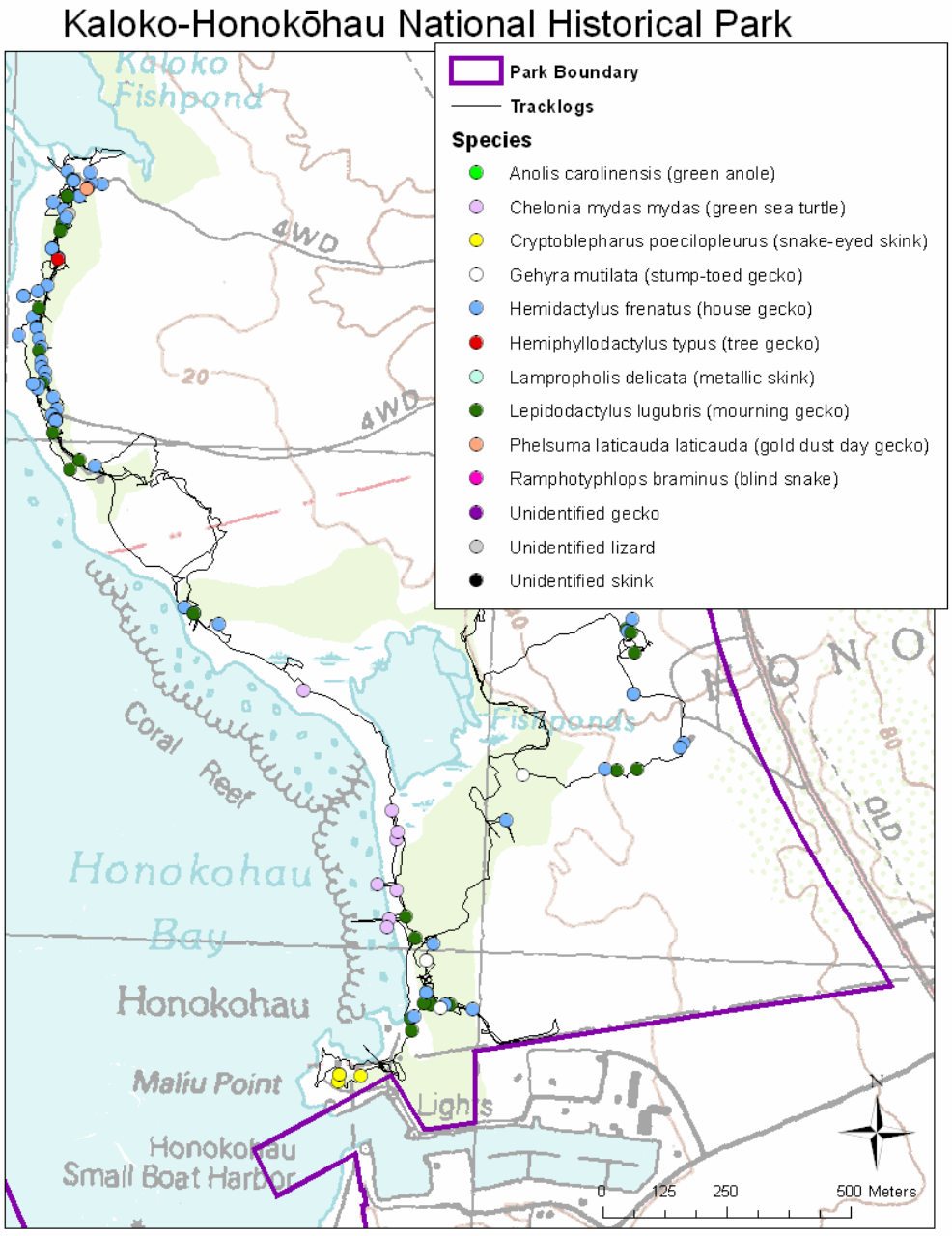

Figure 2. Map of survey tracks and herpetofauna encounters at Kaloko-Honokōhau National Historical Park, 2004.

Pu`ukoholā Heiau National Historic Site

PUHE had the lowest herpetofauna diversity of the parks surveyed, with only two families encountered on park property for a total of three species (Table 1). One of these species, the house gecko (*Hemidactylus frenatus*), was vastly more abundant than the other two species of herpetofauna found in the park, though the gold dust day gecko (*Phelsuma laticauda laticauda*), while still a relatively recent introduction to the Island of Hawai`i, has already gained a foothold. It is not known when this gecko arrived on the Island of Hawaii; it was first released in Mānoa Valley on the Island of Oahu in 1974.

The third and last species of herpetofauna encountered at PUHE was the blind snake. This seldom-encountered fossorial snake was quite common in comparison to the other two parks investigated. Six individuals were found at PUHE compared to one at PUHO and none at KAHO. A total of four out of the six individuals that were found at PUHE were encountered on tree trunks, all between 0.5 m and 1.5 m above ground level (Figure 3).

Figure 3. A blind snake on the trunk of a kiawe tree at Pu`ukohola Heiau National Historic Site at night, August 26, 2004.

Survey routes and sites of herpetofauna encounters at PUHE are illustrated in the following figure.

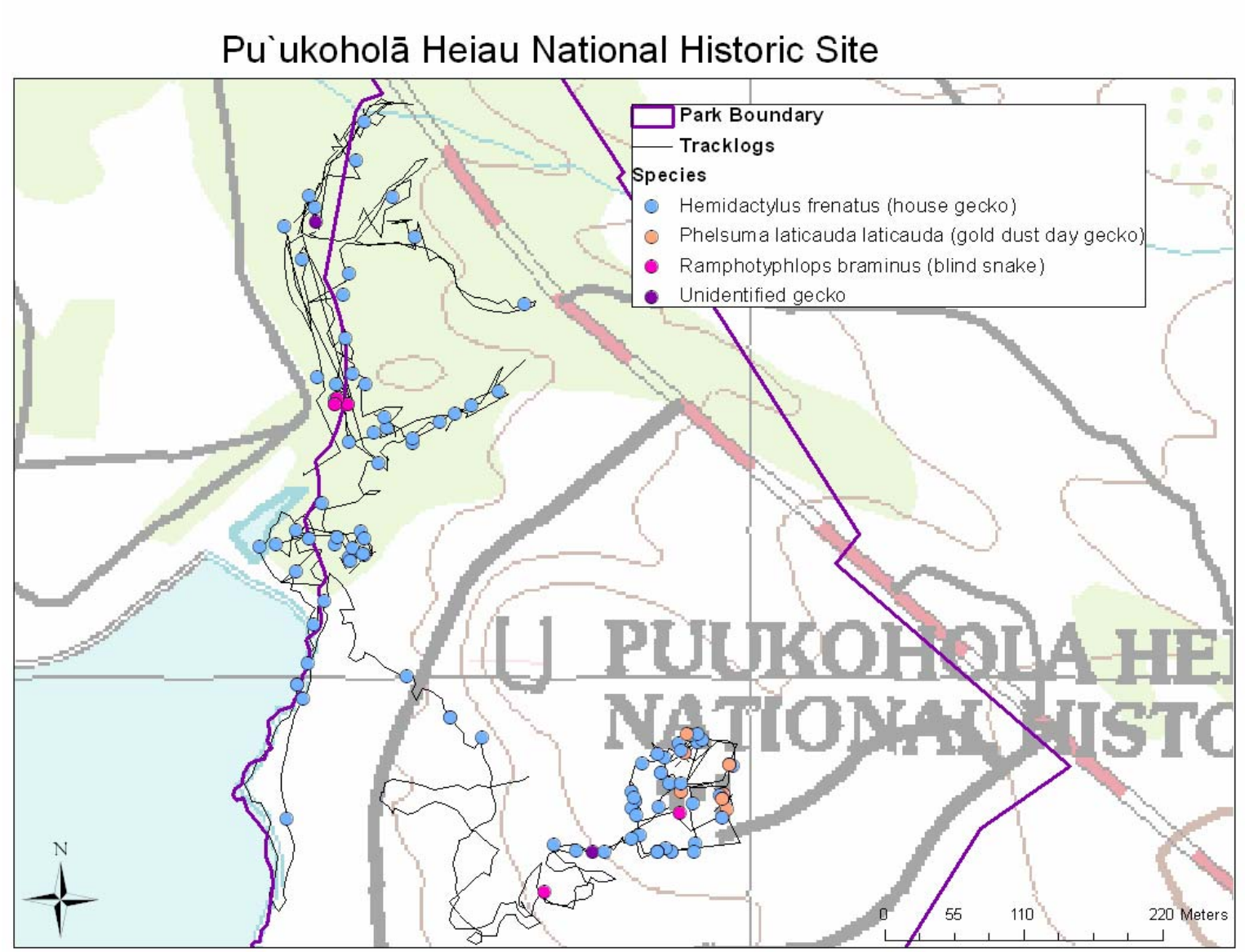

Figure 4. Map of survey tracks and herpetofauna encounters at Pu`ukohola Heiau National Historic Site, 2004.

Relative Abundance and Habitat Associations in all three West Hawai`i National Parks

Table 3 lists qualitative estimates of the abundance of all species encountered based on definitions used in NPSpecies, the National Park Service biodiversity database, which are provided in Appendix B.

Table 3. *Qualitative estimates of herpetofauna encountered in the three West Hawai`i national parks, July – September 2004.*

			Abundance*		
Family	**Scientific name**	**Common name**	**PUHO**	**KAHO**	**PUHE**
Bufonidae	Bufo marinus	giant toad, cane toad, bufo toad, bufo	-	-	-
Chamaeleonidae	Chamaeleo jacksonii xantholophus	Jackson's chameleon	-	-	-
Cheloniidae	Chelonia mydas mydas	Pacific green sea turtle, green sea turtle, honu	C	C	-
Gekkonidae	Gehyra mutilata	stump-toed gecko	C	U	-
Gekkonidae	Hemidactylus frenatus	house gecko	A	A	A
Gekkonidae	Hemiphyllodactylus typus	tree gecko	R	R	-
Gekkonidae	Lepidodactylus lugubris	mourning gecko	A	A	-
Gekkonidae	Phelsuma laticauda laticauda	gold dust day gecko	C	U	U
Iguanidae	Iguana iguana	green iguana, iguana	-	-	-
Leptodactylidae	Eleutherodactylus coqui	coqui treefrog, coqui	-	-	-
Leptodactylidae	Eleutherodactylus planirostris	greenhouse frog	-	-	-
Polychridae	Anolis carolinensis	green anole	U	-	-
Scincidae	Cryptoblepharus poecilopleurus	oceanic snake-eyed skink, snake-eyed skink	-	U	-
Scincidae	Lampropholis delicata	metallic skink	C	-	-
Typhlopidae	Ramphotyphlops braminus	brahminy blind snake, island blind snake, Hawaiian blind snake, blind snake	R**	-	U

* Abundance: R=rare, U=uncommon, C=common, A=abundant

** Apparent rarity may be an artifact of secretive behavior

Looking at the three parks together, some trends worth noting become apparent. Figure 5 illustrates the habitat associations of all the species encountered throughout all of the West Hawai`i national parks.

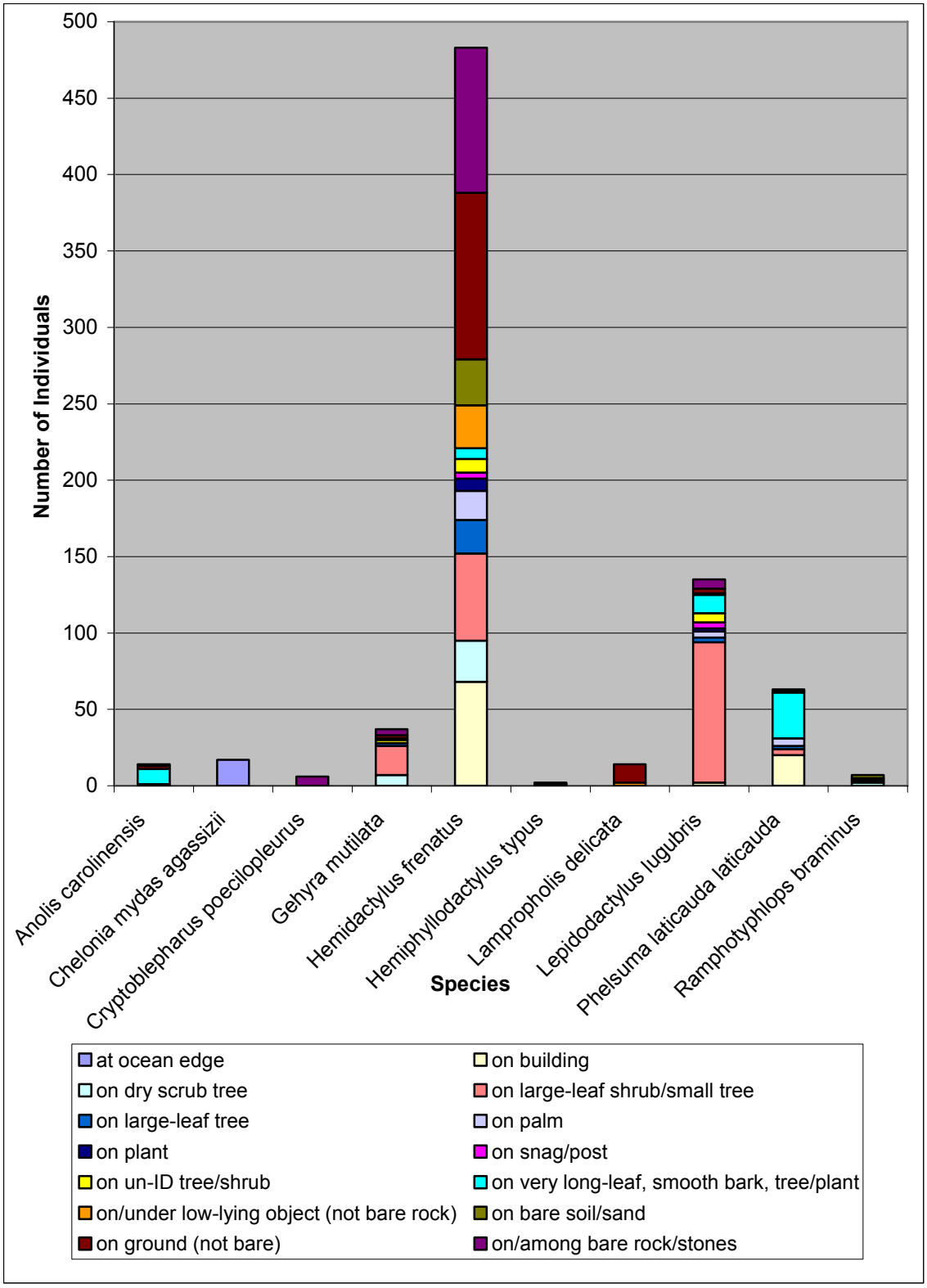

Figure 5. Number of herpetofauna encountered in the West Hawai`i national parks by vegetation type, July – September 2004. (See Appendix A for a list of common and scientific names.)

All of the species found had one or perhaps two clear preferences in habitat types, except for the house gecko. The house gecko was the most abundant species at all of the parks investigated, and was found rather evenly throughout a number of different habitat types. The one species other than the house gecko that had two seemingly unrelated habitat type preferences was the gold dust day gecko. This species was encountered largely on plants and trees with smooth bark and markedly long leaves (e.g., hala [*Pandanus sp.*] and ti [*Cordyline fruticosa*]), as well as on the even surface of the walls of buildings.

DISCUSSION

None of the alien species of concern were encountered at any of the West Hawai`i national parks surveyed. However, one of the difficulties with analyzing survey results is evaluating negative data. Simply because none of these species were found does not necessarily mean that undiscovered populations do not exist within the parks. Nevertheless, due to the small sizes of the parks surveyed, we were able to examine large representative segments of their total area – most notably areas that experience high levels of human contact and thus most likely to have newly introduced exotic species.

At PUHO, several factors lead us to believe that encroachment by alien species of concern will begin shortly or has in fact already begun. First, while no individuals were encountered during the surveys, there have been two reports of Jackson's chameleons in the park by park staff. Both of these sightings were immediately adjacent to the parking areas, however, and were likely recent introductions by park visitors. Adding support to this is the fact that there have been no juveniles reported, which could indicate a breeding population. However, if there are no breeding populations of Jackson's chameleon within the park yet, it is likely that there will be soon. Reports of Jackson's chameleon populations from areas within just a few kilometers of the park are numerous, and it is only a matter of time before they establish a population in the park, with or without human aid.

No coqui frogs have yet been reported from PUHO, and none are yet suspected, though, like the Jackson's chameleon, many populations of coqui frogs have been reported within a few kilometers of the park.. The close proximity of these populations makes introduction into the parks a likely event in the near future, either by human-mediated accidental transport or simply through unaided population expansion. However, given that the coastal segment of the park is arid, the population will probably be small and patchy. If populations become established they will possibly be restricted to cultivated areas near the visitor center and perhaps the very few sources of fresh water. The upslope botanical garden is at a higher risk by being especially close to known populations of coqui frogs, as well as the fact that the garden tends to be wetter (and thus more conducive to amphibian habitation). The reports of iguana from areas near the park have been few in number, and the status of their population is unknown.

In regards to the total number of herpetofauna present, PUHO stands out among the three parks surveyed in its comparatively high number of families and species. One reason for this is the presence of the upslope botanical garden. This plot has markedly different vegetation, elevation, and weather from the coastal segment of the park. The subsequent difference in habitat contributes to the park's overall high species diversity.

The green sea turtle, which was only found at PUHO and KAHO, may actually be an incidental visitor at PUHE. Although there are no reports of green sea turtles from this national park (with the exception of a shark-predated carcass washed onto shore), there are reports from Spencer Beach County Park, a short distance away. Because the water at PUHE is murky due to the adjacent harbor, it is difficult to determine whether or not green sea turtles are present, though with the bay's close proximity to Spencer Beach,

occasional visitation is not unlikely. It should be noted, however, that the high incidence of sharks in the bay at PUHE may cause green sea turtles to avoid the area.

One species in particular, found at all of the parks, merits additional attention. The gold dust day gecko is a relatively recent, rapidly spreading introduction to the Island of Hawai`i. It currently can be found in localized distributions near parking lots at all three of the parks surveyed. This species has successfully colonized the park structures such as buildings and trailers as well as the some of the surrounding vegetation. Much of the vegetation adjacent to the park structures that has been colonized by this species is characterized by long, large leaves and smooth bark; the tendency to inhabit vegetation of this general classification as well as the sides of buildings would seem to indicate a preference for smooth surfaces. It will be worth noting whether the day gecko stays limited to these particular habitats or expands into surrounding areas and novel habitats. This species' aggressive behavior and history of rapid colonization, as observed throughout many of the populated areas of Western Hawai`i, suggest that it will eventually spread to other areas in the parks.

Another species that deserves mention is the generally fossorial blind snake. Arboreality among blind snakes has been anecdotally documented on a number of occasions (Das and Wallach 1998), though the frequency in which they were found on trees compared to those that were found on the ground at PUHE was surprising. One potential cause for this unusual behavior may be tied to resources: unexploited tree-dwelling invertebrates could be a valuable food source.

SUMMARY AND RECOMMENDATIONS

Based on the results of this survey, the three parks investigated in this study do not yet have any established populations of alien species of concern within their boundaries. However, they do harbor a number of other herpetofauna, some of which are abundant. Although not yet identified as alien species of concern, these species may be inflicting undetected damage upon native Hawaiian species and habitats.

Two species of herpetofauna not yet identified as a species of concern, the gold dust day gecko, and the greenhouse frog (*Eleutherodactylus planirostris*), may actually pose more of a threat than suggested at the inception of this project. Regarding the gold dust day gecko, it is impossible to predict its eventual impact at this early stage of colonization. However, based on this gecko's record for expansion throughout West Hawai`i, it could become a dominant presence in all three of the West Hawai`i parks, perhaps to the detriment of native Hawaiian fauna. The greenhouse frog may not be a substantial threat at the West Hawai`i parks due to its need for high levels of moisture, but it does have the potential to inhabit other lowland areas with suitable habitat in dense aggregations. The West Hawai`i national parks may, for the most part, prove to be too dry for the greenhouse frog, but this species may merit the status of "alien species of concern" in the context of other lowland NPS properties throughout Hawai`i.

In light of the data presented here, I recommend a periodic small-scale monitoring program for all of the parks investigated in this study. The principal goal for such a program would be to alert park staff of invasions of alien species of concern. Additionally, a long-term monitoring program such as this would determine population trends of all species of herpetofauna found within the parks, alerting park staff to population expansions of supposedly benign species and thus allowing for informed management decisions before the situation is beyond control. Based on future studies and monitoring, the list of alien species of concern will need to be revised periodically to reflect new knowledge regarding the impact of alien species.

ACKNOWLEDGMENTS

I would like to thank A. Cocke for her tireless work on the GIS portion of this project and D. Hu for her help and guidance throughout. Collaboration with park staff was essential to this project's completion, and I am especially grateful for the help of M. Laber (PUHO), S. Beavers (KAHO), and S. Bond (PUHO and KAHO). I also thank David Duffy, Unit Leader: the Pacific Cooperative Studies Unit (PCSU), University of Hawai`i at Mānoa. This project was carried out under a cooperative agreement between the National Park Service and the University of Hawai`i at Mānoa (No. CA 8012-AO-001).

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Appendix A: Reference List of Common and Scientific Names

Scientific name	Common name
Anolis carolinensis	green anole
Bufo marinus	giant toad, cane toad, bufo toad, bufo
Chamaeleo jacksonii xantholophus	Jackson's chameleon
Chelonia mydas mydas	pacific green sea turtle, green sea turtle, honu
Cryptoblepharus poecilopleurus	oceanic snake-eyed skink, snake-eyed skink
Eleutherodactylus coqui	coqui treefrog, coqui
Eleutherodactylus planirostris	greenhouse frog
Gehyra mutilata	stump-toed gecko
Hemidactylus frenatus	house gecko
Hemiphyllodactylus typus	tree gecko
Iguana iguana	green iguana, iguana
Lampropholis delicata	metallic skink
Lepidodactylus lugubris	mourning gecko
Phelsuma laticauda laticauda	gold dust day gecko
Ramphotyphlops braminus	brahminy blind snake, island blind snake, Hawaiian blind snake, blind snake

APPENDIX B: NPSPECIES DESCRIPTIONS AND DEFINITIONS FOR ANIMAL SPECIES ABUNDANCE

Abundant	May be seen daily, in suitable habitat and season, and counted in relatively large numbers.	
Common	May be seen daily, in suitable habitat and season, but not in large numbers.	
Uncommon	Likely to be seen monthly in appropriate season/habitat. May be locally common.	
Rare	Present, but usually seen only a few times each year**.**	
Occasional	Occurs in the park at least once every few years, but not necessarily every year.	
Unknown	Abundance unknown.	
NA	Not Applicable – Abundance does not apply to the scientific name in the park.	All names on a park's list that do not have a *Park Status* of Present should have a *Residency* of NA.

The above definitions are an excerpt from the NPSpecies data dictionary (Wotawa 2004).

APPENDIX C: DETAILED OBSERVATION DATA

Start Date	Start Time	End Time	Duration (hrs:min)	Anolis carolinensis	Chelonia mydas mydas	Cryptoblepharus poecilopleurus	Gehyra mutilata	Hemidactylus frenatus	Hemiphyllodac-tylus typus	Lampropholis delicata	Lepidodactylus lugubris	Phelsuma laticauda laticauda	Ramphotyphlops braminus	Unidentified gecko	Unidentified lizard	Unidentified skink
KAHO																
20040908	10:10	12:46	03:36					2								
20040909	07:53	09:21	01:28									17				
20040909	09:37	11:15	02:38					1							1	
20040911	09:49	09:50	00:01		1											
20040911	10:48	12:58	02:10		4											
20040911	13:24	15:11	02:47			6					1					
20040831	19:45	00:11	04:26				2	28			18					
20040901	19:51	01:13	05:22		9		3	6			19					
20040902	19:55	22:55	03:00				1	13			8					
20040907	20:26	00:59	05:33				4	33			9					
20040909	20:24	20:25	00:01						1							
20040909	20:57	23:40	03:43					5			2					
PUHE																
20040816	11:46	12:34	00:48											1		
20040817	10:12	11:30	01:18					8								
20040818	07:05	09:11	02:06					9								
20040818	09:28	10:20	01:52					1								
20040819	06:55	08:30	02:35					3								
20040819	08:51	10:08	01:17					8								
20040819	10:58	11:48	01:50					10								
20040823	07:10	08:43	02:33					2						3		
20040823	08:55	09:39	01:44					3								
20040823	10:30	12:15	02:45					15				1				
20040824	07:13	09:39	02:26					31								
20040824	10:27	11:11	01:44					4				2				
20040831	08:30	12:00	04:30									2				
20040915	08:30	12:05	04:35					4				7				
20040824	20:10	00:29	04:19					34					1			
20040825	00:48	00:49	00:01										1			

Start Date	Start Time	End Time	Duration (hrs:min)	Anolis carolinensis	Chelonia mydas mydas	Cryptoblepharus poecilopleurus	Gehyra mutilata	Hemidactylus frenatus	Hemiphyllodac-tylus typus	Lampropholis delicata	Lepidodactylus lugubris	Phelsuma laticauda laticauda	Ramphotyphlops braminus	Unidentified gecko	Unidentified lizard	Unidentified skink
20040825	17:59	00:13	06:12					91								
20040826	20:46	22:01	01:15					47					4			
20040826	23:00	00:29	01:29					47								
PUHO																
20040728	10:39	11:54	01:15									18				
20040729	07:26	09:32	02:06					1								
20040802	07:24	7:25	00:01		3											
20040802	08:10	10:35	02:25					2			4			1	1	
20040803	08:09	10:05	02:56	2						1	1	1				1
20040804	06:15	09:36	03:21											3		
20040804	09:50	11:45	02:55											1	1	
20040805	06:40	09:39	03:59											1		
20040809	12:52	13:25	01:33									1		7		
20040810	06:03	08:03	02:00					6								
20040810	08:45	09:30	01:45					2								
20040810	10:10	10:36	00:26					1								
20040810	15:38	17:59	02:21	2						4		1				
20040811	06:14	07:01	01:47					3								
20040811	17:58	18:28	01:30									6				
20040813	06:57	09:47	03:50	2						1	5	2				
20040813	10:03	11:38	02:35	2						2		1				
20040910	14:41	14:42	00:01							1						
20040910	15:03	15:23	00:20	1									1			
20040914	08:30	10:53	02:23	1				1		5		2				2
20040914	11:08	12:30	01:22	3							1					
20040729	20:24	23:06	03:42					38			4	2				
20040802	20:21	21:36	01:15					2			4			2		
20040804	20:38	22:20	02:42				6	1								
20040804	22:55	01:01	02:06					6			27					
20040805	20:28	22:59	03:31	1			5	4	1		8					
20040811	20:20	22:35	02:15				14	6			24					
20040911	01:00	01:10	00:10				2	4								

APPENDIX D: PHOTOGRAPHS OF ALL HERPETOFAUNA PRESENT IN THE WEST HAWAI`I NATIONAL PARKS

(Figure A8 photo courtesy of Fred Kraus, all other photos by J. Bazzano)

Figure A1. Green anole.

Figure A2. Green sea turtle.

Figure A3. Snake-eyed skink.

Figure A4. Metallic skink.

Figure A5. Stump-toed gecko.

Figure A6. House gecko.

Figure A7. Mourning gecko.

Figure A8. Tree gecko.

Figure A9. Gold dust day gecko.

Figure A10. Blind snake.

Figure A11. Cane toad.

APPENDIX E: PHOTOGRAPHS OF HERPETOFAUNA LIKELY TO BE ENCOUNTERED IN THE WEST HAWAI`I NATIONAL PARKS IN THE NEAR FUTURE

Figure A12. Jackson's chameleon. (Photo by J. Bazzano).

Figure A13. Coqui treefrog. (Photo by Forrest Brem, © Forrest Brem).

Figure A14. Green iguana. (Photo by Jerry Bauer, NPS website).